HMA PROBLEMS

1. A 13-foot wide lane is being placed at a planned rate of 275 lb/yd². The paving begins at Station 12 + 72. After the sixth load, the paver is at Station 19 + 90. The weigh tickets for the six loads are:

1.	47,800 lb	2.	48,100 lb
3.	48,200 lb	4.	47,900 lb
5.	47,700 lb	6.	47,800 lb

Calculate the actual yield in lb/yd² to the nearest first decimal place (0.0)..

2. Using the data from Problem No. 1, compare the actual rate of spread with the planned rate in lb/lft to the nearest whole number (0).

3. Using the data from Problem No.1, compare the actual rate of spread with the planned rate in tons/lft to the nearest first decimal place (0.0).

4. A seal coat of Asphalt Emulsion RS-2 is placed with a Grace 300 Series distributor equipped with 1/8 in. nozzles. The width of the seal coat is 12 feet and the plan application rate is 0.31 gal/yd^2. The operator plans to use a tach speed of 700 feet / min. Is this correct?

5. Seal coating was started at Station 46 + 24 and ended at Station 75 +17. The planned application rate is 30 lb/yd² of cover aggregate size No. 9. The width of the application was 11 feet. Four loads of cover aggregate were used as follows:

    1. 27,500 lbs
    2. 26,900 lbs
    3. 26,400 lbs
    4. 27,100 lbs

    Compute the actual rate of spread to the nearest first decimal place (0.0).

6. The planned quantity of AE-90S for the seal coat in Problem No. 5 is 0.65 gal/yd². The temperature of the asphalt was 237º F and 2210 gallons were used. Calculate the actual application rate to the nearest second decimal place (0.00).

7. Pavement markings consisting of a white edge line, a broken centerline and a yellow edge line have been placed between Station 97 + 12 and Station 121 + 37 on the eastbound lane of a four-lane divide roadway. Gaps were left at two intersections. The first gap was from Station 101 + 33 to Station 102 + 33 and the second gap was from Station 115 + 00 to Station 116 + 10. Compute the pay quantity of pavement markings in feet to the nearest whole number (0).

    1. White Edge Line =
    2. Yellow Edge Line =
    3. Broken Line =

8. 2,100 tons of surface mixture was placed beginning at Station 17 + 23 and ending at Station 100 + 13. The mixture was placed in two passes with the first pass 13 feet wide in the driving lane and the second pass 11 feet wide in the passing lane for a total of 24 feet. The planned laydown rate is 165 lb/yd². Determine the location of the density cores using the theoretical laydown rate. The beginning of the day started Lot No. 3 and the following are the next random numbers.

1)	.576	.730	7)	.810	.159
2)	.092	.948	8)	.081	.277
3)	.669	.726	9)	.982	.468
4)	.609	.482	10)	.095	.801
5)	.971	.824	11)	.509	.025
6)	.053	.699	12)	.371	.059

9. Using the information from Problem No. 8, calculate the actual laydown rate for the day. Did the Contractor underrun or overrun and how could this be corrected?

10. Given the following information, calculate the Quality Assurance Adjustment for Density and Mix.

9.5 mm Surface
Unit Price = $42.00 / ton

Lot Size = 2,400 Tons
JMF: % Binder = 5.6 %
Air Voids = 4.0 %
VMA = 15.5 %

Sublot No.	% Binder	Air Voids	VMA	Density (% MSG)
1	5.7	3.6	15.0	91.1
2	5.1	4.4	15.9	90.7
3	5.6	2.9	15.6	89.9
4	5.8	3.8	15.1	92.9

INDIANA DEPARTMENT OF TRANSPORTATION

HOT MIX ASPHALT ANALYSIS FOR QUALITY ASSURANCE

CONTRACT NO. _____ PLANT NO. _____ LOT NO. _____ DATE _____

MIXTURE _____ DMF/JMF NO. _____

Mixture & Density	SUBLOT 1			SUBLOT 2			SUBLOT 3			SUBLOT 4		
	Pay Factor	Mult		Pay Factor	Mult		Pay Factor	Mult.		Pay Factor	Mult.	
% Binder		0.20			0.20			0.20			0.20	
Air Voids		0.35			0.35			0.35			0.35	
VMA		0.10			0.10			0.10			0.10	
Density		0.35			0.35			0.35			0.35	
SCPF												

* Requires submittal to the Materials and Tests Division for Failed Material Investigation

QUALITY ASSURANCE ADJUSTMENTS							
Sublot 1 Quantity L (tons)	Sublot 1 Adjustment ($)	Sublot 2 Quantity L (tons)	Sublot 2 Adjustment ($)	Sublot 3 Quantity L (tons)	Sublot 3 Adjustment ($)	Sublot 4 Quantity L (tons)	Sublot 4 Adjustment ($)

U = Unit Price for Material, $/Ton

Quality Assurance Adjustment = L x U x (SCPF – 1.00) / MAF

PROBLEM SOLUTIONS

1.

1) Determine the total weight of mix placed: 287,500 lb

2) Determine the distance paved: (19+90) – (12+72) = 718 lft.

3) Determine the area paved: $\frac{718 \text{ ft} \times 13 \text{ ft}}{9 \text{ yd}^2/\text{ft}^2} = 1{,}037 \text{ yd}^2$

4) Calculate the actual rate of spread: $\frac{287{,}500 \text{ lb}}{1{,}037 \text{ yd}^2} = 277.2 \text{ lb/yd}^2$

5) This is within 2.2 lb/yd² of the planned rate

2.

1) Convert the planned quantity from lb/yd² to lb lft:

$$\frac{1\text{ft} \times 13 \text{ ft} \times 275 \text{ lb/yd}^2}{9 \text{ ft}^2/\text{yd}^2} = 397 \text{ lb/lft}$$

2) Determine total weight of mix placed: 287,500 lb

3) Determine the distance paved: (19+90) – (12+72) = 718 lft.

4) Calculate the actual rate of spread: $\frac{287{,}500 \text{ lb}}{718 \text{ lft}} = 400 \text{ lb/lft}$

5) The actual rate of 400 lb/lft compares favorably with the planned rate of 397 lb/yd²

3.

1) Convert the planned quantity from lb/yd² to tons/lft

$$\frac{1 \text{ ft} \times 13 \text{ ft} \times 275 \text{ lb/yd}^2}{9 \text{ ft}^2/\text{yd}^2 \times 2000 \text{ lb/ton}} = 0.20 \text{ tons/lft}$$

2) Determine total weight of mix placed: $\frac{287{,}500 \text{ lb}}{2{,}000 \text{ lb/ton}} = 143.75$ tons

3) Determine the distance paved: (19+90) – (12+72) = 718 lft.

4) Calculate the theoretical quantity in tons: 718 lft x 0.20 tons/lft = 143.6 tons

5) Calculate the % of overrun or underrun:

$$\frac{143.75 \text{ tons} - 143.6 \text{ tons}}{143.6 \text{ tons}} = \frac{0.15}{143.6} = 0.10 \text{ \% overrun}$$

4.

1) Determine the spray output in gals/min. from the manufactures information in Figure 5-6. For a Grace 300 Series with 1/8 in. nozzles, the output is 100 gals/min. with a pump pressure of 35 psi.

2) Compute the speed:

$$V = \frac{9 \times Q}{W \times A} = \frac{9 \text{ ft}^2/\text{yd}^2 \times 325 \text{ gals/min.}}{12 \text{ ft} \times 0.31 \text{ gals/yd}^2} = 786 \text{ ft/min}$$

3) No, she needs to increase her speed.

5.

1) Determine the total weight of mix placed: 107,900 lb

2) Determine the distance paved: (75+17) – (46+24) = 2893 lft

3) Determine area paved:

$$\frac{2{,}893 \text{ ft} \times 11 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} = 3{,}536 \text{ yd}^2$$

4) Calculate actual rate of spread:

$$\frac{107{,}900 \text{ lb}}{3{,}536 \text{ yd}^2} = 30.5 \text{ lb / yd}^2$$

5) This is within 0.5 lb or about 2 % of the planned rate.

6.

1) Convert gallons used at 237º F. to gallons at 60º F.:

$$V = \frac{V}{K(T-60^{o}) + 1} = \frac{2{,}210 \text{ gals.}}{0.00025/^{o}F(237^{o}-60^{o}) + 1} = 2{,}116.4 \text{ gal. @ } 60^{o} \text{ F}$$

2) Determined area paved: See 3) from Problem No. 5 = 3, 536 yd²

3) Compute actual rate: $\frac{2{,}116.4 \text{ gal}}{3{,}536 \text{ yd}^2} = 0.60 \text{ gals/yd}^2$

4) Compare with planned rate: $\frac{(0.65 \text{ gal/yd}^2 - 0.60 \text{ gal/yd}^2) \times 100}{0.65 \text{ gals/yd}^2} = 7.7 \%$ low

5) This rate of application is to low to be acceptable. The pump output and the tach speed should be checked.

7.

1) Determine the distance stripped:
   (121+37) – (116+10) = 527 ft.
   (115+00) – (102+33) = 1,267 ft.
   (101+33) – (97+12) = 421 ft.
   2,215 ft.

2) Determine the pay quantity:
   a. White Edge Line = 2,215 lft
   b. Yellow Edge Line = 2,215 lft
   c. Broken Line is 10 ft in every 40 ft so multiply by 0.25
      2,215 x 0.25 = 554 lft

8.

1) Determine the length of each lane placed: (100+13) – (17+23) = 8,290 lft

2) Determine how many theoretical tons per lane:

13 foot wide lane:

$$\frac{8{,}290 \text{ ft} \times 13 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} = 11{,}974.4 \text{ yd}^2$$

$$\frac{165 \text{ lb/yd}^2 \times 11{,}974.4 \text{ yd}^2}{2000 \text{ lb ton}} = 987.9 \text{ tons}$$

11 foot wide lane:

$$\frac{8{,}290 \text{ ft} \times 11 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} = 10{,}132.2 \text{ yd}^2$$

$$\frac{165 \text{ lb/yd}^2 \times 10{,}132.2 \text{ yd}^2}{2000 \text{ lb/ton}} = 835.9 \text{ tons}$$

3) Determine the length and stationing of each sublot:

Start with 13 foot wide lane
Sublot 3-1
Sublot of surface = 600 ton

$$\frac{165 \text{ lb/yd}^2 \times (13 \text{ ft} \times 1 \text{ ft/ft})}{9 \text{ ft}^2/\text{yd}^2} = 238.3 \text{ lb/ft}$$

$$\frac{600 \text{ ton} \times 2000 \text{ lb/ton}}{238.3 \text{ lb/ft}} = 5{,}035.7 \text{ ft} \text{ say } 5{,}036 \text{ lft}$$

Sublot 3-1 starts at 17+23 (13 foot wide lane)
ends at 1,723 + 5,036 = 6,759 = 67+59 (13 foot wide lane)

Sublot 3-2 starts at 67+59 (13 foot wide lane)

(100+13) – (67+59) = 10,013 – 6,759 = 3,254 lft

$$\frac{3{,}254 \text{ ft} \times 13 \text{ ft} \times 165 \text{ lb/yd}^2}{9 \text{ ft}^2/\text{yd}^2} = \frac{775{,}536.7 \text{ lb}}{2{,}000 \text{ lb/ton}} = 387.8 \text{ tons}$$

Start with 11 foot wide lane 600 tons – 387.8 tons = 212.2 tons

$$\frac{165 \text{ lb/yd}^2 \times (11 \text{ ft} \times 1 \text{ ft/ft})}{9 \text{ ft}^2/\text{yd}^2} = 201.7 \text{ lb/ft}$$

$$\frac{212.2 \text{ ton} \times 2000 \text{ lb/ton}}{} = 2{,}104.1 \text{ ft} \text{ say } 2{,}104 \text{ lft}$$

201.7 lb / ft

Sublot 3-2 starts at 67+59 goes to 100+13 (13 ft wide lane)
and from 17+23 to 38+27 (11 ft wide lane)

Sublot 3-3 starts at 38+27 (11 ft wide lane)

$$\frac{165 \text{ lb/yd}^2 \times (11 \text{ ft} \times 1 \text{ ft/ft})}{9 \text{ ft}^2/\text{yd}^2} = 201.7 \text{ lb/ft}$$

$$\frac{600 \text{ ton} \times 2000 \text{ lb/ton}}{201.7 \text{ lb/ft}} = 5{,}949.4 \text{ ft say } 5949 \text{ lft}$$

38+27 + 5949 = 9776 = 97+76
Sublot 3-3 starts at 38+27 goes to 97+76 (11 ft wide lane)

Sublot 3-4 starts at 97+76 (11 ft wide lane)

End of Day is at 100+13 (10013) – (9776) = 237 lft into Sublot 3-4

4) Locate the cores

Sublot 3-1 5,036 feet long: Starts at 17+23 to 67+59 (13 foot wide lane)

5,036 x 0.576 = 2900.7 say 2901 lft: (17+23) + (29+01) = 46+24
Offset: 13 ft x 0.730 = 9.49 say 9.5 ft
5,036 x 0.092 = 463.3 say 463 lft: (17+23) + (4+63) = 21+86
Offset: 13 ft x 0.948 = 12.32 ft say 12.3 ft

Sublot 3-1 cores at
46+24 with 9.5 ft offset
21+86 with 12.3 ft offset

Sublot 3-2: You will need to break down how much of Sublot 3-2 is going to be in each lane. Also need to look at the next two random numbers and see were they will be in the Sublot.
67+59 to 100+13 (13 ft wide) 387.8 tons 64.6% (< 0.646)
and 17+23 to 38+27 (11 ft wide) 212.2 tons 35.4 % (> 0.646)
13 ft wide is 3,254 lft 11 ft wide is 2,104 lft

Next random number 0.669 which is > 0.646: 669 - .646 = 0.023

0.023 x 2,104 lft = 48.39 say 48 lft: (17+23) + (0+48) = 17+71
Offset: 0.726 x 11 ft = 7.99 say 8.0 ft

Next random number 0.609 which is < 0.646: 609 - .646 = -0.037

0.037 x 3,254 lft = -120.40 lft say -120 lft back form the end of the 13 foot lane.: (100+13) – 120 = 98+93

Offset: 0.482 x 13 ft = 6.30 ft

Sublot 3-2 cores at

17+71 with 8.0 ft offset (11 ft lane)

98+93 with 6.3 ft offset (13 ft lane)

Sublot 3-3: starts at 38+27 goes to 97+76 (11 ft wide lane)

5949 lft

5949 lft x 0.971 = 5776.5 lft say 5776: (38+27) + 5,776 = 96+03

Offset: 0.824 x 11 ft = 9.06 ft say 9 ft

5949 lft x 0.053 = 315.3 lft say 315: (38+27) + 315 = 41+42

Offset: 0.699 x 11 ft = 7.69 ft say 7.7 ft

Sublot 3-3 cores at

96+03 with 9.0 ft offset (11 ft lane)

41+42 with 7.7 ft offset (11 ft lane)

Sublot 3-4: starts at 97+76 day production ends at 100+13: 237 lft

5949 lft x 0.810 = 4818.7 lft Note: Not in today's production

5949 ft x 0.081 = 481.9 lft Note: Not in today's production

9.

1) Determined Area placed : 100+13 – 17+23 = 8290 lft

13 foot lane: $\frac{8290 \text{ ft} \times 13 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} = 11{,}974.4 \text{ yd}^2$

11 foot lane: $\frac{8290 \text{ ft} \times 11 \text{ ft}}{9 \text{ ft}^2/\text{yd}^2} = 10{,}132.2 \text{ yd}^2$

$11{,}974.4 \text{ yd}^2 + 10{,}132.2 \text{ yd}^2 = 22{,}106.6 \text{ yd}^2$

2) Determine lay rate:

$\frac{2{,}100 \text{ tons} \times 2{,}000 \text{ lb/ton}}{22{,}106.6 \text{ yd}^2} = 189.99 \text{ lb/yd}^2$ say 190 lb/yd^2

The Contractor overran.

The tonnage should have been checked on a regular basis to prevent this type of problem. The overrun should not be made up on the next day's production.

Problem No 10

HOT MIX ASPHALT ANALYSIS FOR QUALITY ASSURANCE

CONTRACT NO. _____ PLANT NO. _____ LOT NO. _____ DATE _____

MIXTURE _____ DMF/JMF NO. _____

Mixture & Density	SUBLOT 1			SUBLOT 2			SUBLOT 3			SUBLOT 4		
	Pay Factor	Mult		Pay Factor	Mult		Pay Factor	Mult.		Pay Factor	Mult.	
% Binder	1.04	0.20	0.2080	1.02	0.20	0.2040	1.05	0.20	0.2100	1.00	0.20	0.2000
Air Voids	1.00	0.35	0.3500	1.00	0.35	0.3500	0.95	0.35	0.3325	0.95	0.35	0.3325
VMA	1.05	0.10	0.1050	1.00	0.10	0.1000	0.95	0.10	0.0950	1.00	0.10	0.1000
Density	1.05	0.35	0.3675	1.00	0.35	0.3500	0.95	0.35	0.3325	1.03	0.35	0.3605
SCPF			1.03			1.00			0.97			0.99

* Requires submittal to the Materials and Tests Division for Failed Material Investigation

QUALITY ASSURANCE ADJUSTMENTS							
Sublot 1 Quantity L (tons)	Sublot 1 Adjustment ($)	Sublot 2 Quantity L (tons)	Sublot 2 Adjustment ($)	Sublot 3 Quantity L (tons)	Sublot 3 Adjustment ($)	Sublot 4 Quantity L (tons)	Sublot 4 Adjustment ($)
1000	+ 900	1000	0	1000	- 900	1000	- 300

U = Unit Price for Material, $/Ton

Quality Assurance Adjustment = L x U x (SCPF – 1.00) / MAF